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RECOGNITION OF THE FEMALE OF *TRACHELIODES FOVEOLINEATUS* (VIERECK), WITH DESCRIPTION OF THE MALE AND LARVA (HYMENOPTERA: SPHECIDAE: CRABRONINAE)

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Abstract.—Pate's redescription of the type female of *Tracheliodes foveolineatus* (Viereck) is importantly emended. The first description of the male is given, and attributes permitting recognition of the males of all three existent Nearctic species are specified. The diapaused mature larva is also described and compared with those of what is probably the Nearctic *T. amu* Pate, and the Palearctic *T. quinquenotatus* (Jurine). Larvae of all three are readily distinguished, but the Nearctic species are more similar to each other than either is to *T. quinquenotatus*.

Six female wasps from an elder trapnest, placed at Julian, San Diego Co., California, are the fairly rare *T. foveolineatus* (Viereck) by Pate's (1942) key, as are two females loaned by Prof. R. M. Bohart and identified by him as this species. All eight, apart from pygidial puncturation, agree reasonably well with Viereck's (1909) description. However the clypeal teeth, shape of the supraorbital foveae, the foretarsal "pecten," admedian line and notauli, propodeal flanks, and puncturation of the pygidium apparently differ from the female type as described by Pate. Because Pate claimed that his detailed description of the type agrees "in all essential particulars" with a second specimen before him, but not described, it seemed possible that the specimens at hand represented another species. Restudy of Viereck's type shows that is not so. The following emendations to Pate's description need to be made:

The clypeus of the female type is adorned with three apical teeth, as Pate says, but the medial tooth is actually broad and truncate, not rounded as stated and portrayed in his figure 1; in fact, the clypeal margin is strikingly similar to that of his figure 4 (= the male *T. amu* Pate). Figure 1 is also misleading with respect to the supraorbital foveae which are drawn far too low onto the frontal area, are too far removed from the eye margins (from which they are separated by slender beads, in part evanescent in the type and some others), and incorrect in outline. The foveae are noticeably flared anteriorly, of minimal breadth for a distance in the posterior third, and abruptly bent away from the eye margin at their posterior ninths (range in the eight females = R_8 = 0.87–0.93); ratio of relative length to diameter of median ocellar lens = 5.2 (R_8 = 6.1–8.6).

The type is the largest of the nine female specimens that I have seen, with a mean forewing length (tip to costal sclerite) from 1.1–1.3 × the length of the other eight specimens (R_8 = 4.7–5.5). The barely definable (perhaps vestigial) "pecten"

of 5 or so "short, stout bristles" on the fore basitarsus is unlike that figured by Kohl (1915) for *T. curvitarsis* Herr.-Schaeff. Below and about the "pecten" there are similar bristles and hairs, and in smaller specimens a comb is—at best—barely discernible.

The admedian line and notaulus are confined to the anterior third of the mesonotum, the propodeal flanks are not glabrous, and the pygidium has coarse punctures separated by 1–2 diameters. It must also be mentioned that the sparse, short pubescence of the eyes (a generic attribute) is striking in the type, but is barely evident as a few, widely scattered hairs in three fresh emergents among the specimens.

The "basal acarid chambers" of the metasoma, mentioned but not described by Pate, are extremely difficult to detect in the type, if at all, and were probably observed by Pate in his second specimen. When the terga are separated, thin, posteriorly-directed membranous projections from acrotergites 2 through 5 are exposed. Differing progressively in pattern among the terga, these membranes create shallow pockets (<0.3 mm high), over a basal portion of their tergal laminae, within which deutonymphs might shelter and which are wholly covered by the overlying broad apical margin of the preceding tergum. When, as is the case in 5 specimens, an apical margin has not become opaque or the abdomen is strongly bowed ventrally, the margins of the acrotergal membranes are more or less visible without manipulation.

There are several large deutonymphs *on* the type, but it is questionable whether there are any within the putative acarinaria. No mites are present on the other females studied, and there are none within the chambers of a reared disarticulated specimen, nor within the nest from which it was reared. It is not unlikely that, at least occasionally, the very small deutonymphs of a species of *Crabrovidia* are phoretic within the chambers (see Fain, 1973).

The male.—The following description is based upon two male siblings of the six reared females, plus two specimens loaned by Prof. Bohart. All run to *T. foveolineatus* in Pate's (1942) key, the male of which has not been described.

Length of forewing (tip to costal sclerite): $m_8 = 4.4$ ($R_8 = 4.0$–4.9) mm. Slenderer, but resembling female overall, including somewhat weaker apical clypeal teeth: median tooth broad, truncate, tooth on each side half as wide (or nearly so), blunt. As in other described species of *Tracheliodes*, secondary sexual characters not unusual or striking: 13-segmented antennae; strong bands of decumbent silvery pubescence between inner orbits and scapal basin; silvery pubescence extending over clypeus; clypeus flat in profile; supraorbital foveae small, very slender, gradually tapering anteriorly over most of their length (in female narrowed posteriorly), widest posteriorly where flexed, relative length to diameter of median ocellar lens: $m_8 = 2.2$ ($R_8 = 1.8$–2.8), flexed toward hind ocelli at posterior eighth ($R_8 = 0.82$–0.89); dense, decumbent silvery pubescence over subpleural surface of mesothorax (in whole or in part); foreleg trochanter (relative to the forefemur) shorter (female 0.59×, male 0.48×); long sparse cilia (greater than trochanter width) on ventral surface of foreleg trochanter and basal half of forefemur; shorter, more uniform and dense pubescence on midtrochanter and basal half of midfemur; midfemur nearly circular in mid-section; hind tibia not notably "pinched" or subcarinate antero-apically as in female, subellipsoidal in apical third; hind basi-

tarsi nearly straight; metasomal "acarinaria" as in female, on metasomal tergum-2 to the penultimate tergum; no demarcated pygidial area.

Coloration: as in female; ground colors ferruginous, piceous, or black, maculation very variable; the following yellow in all four males: palps, clypeus, scape, flagellum below, pronotum, venter of mesopleuron (nearly all, or in part), scutellum in part, coxae (all or in part), fore and midlegs mostly, most of external surface of hindtibia; dark markings of legs variable, but hindfemora dark in all; metasomal terga 1–3 (2 males), 1–5 (2 males), maculate.

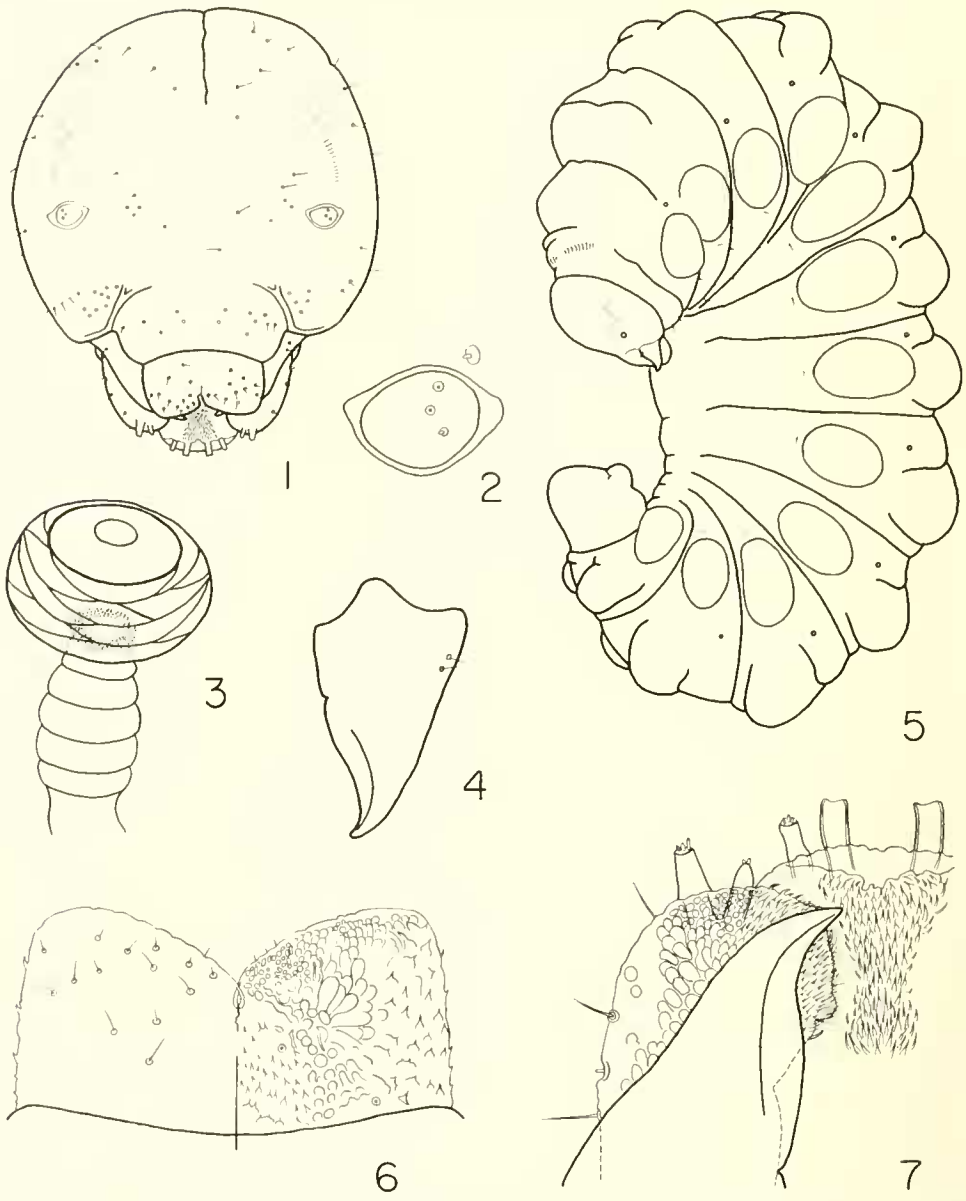
Specimens examined.—Type ♀. California, Shasta Co. Type No. 4994, Academy of Natural Sciences of Philadelphia. ♀, California, Sacramento Co., Davis, 10-26-1950, A. T. McClay; ♀, California, Los Angeles Co., Tanbark Flat, VII-6-1952, J. H. Nakata; ♂, California, Glenn Co., Orland, 6-W, Mar. 1920; ♂ (with cocoon), Nevada, Washoe Co., Verdi, F. D. Parker. All the preceding except the type from the Richard M. Bohart Entomological Museum, University of California, Davis; all determined by R. M. Bohart. California, San Diego Co., Julian, 1,234 m altitude; 6 perfect ♀, 1 pharate imago (partially dismembered within cocoon by siblings) and 2 ♂ from elder trap nest 83-579 (out VIII-27-1983, in IX-11-'83); emergence IX-19-'83: 2 ♀ and 2 ♂; emergence IX-20-'83: 4 ♀; basal cell with a cocooned, diapausing larva.

Diagnosis.—The male of *T. foveolineatus* is distinguished from the closely allied *T. amu* (as judged from Pate's description) by possession of supraorbital foveae, finely striate mesonotum and more coarsely striate pleura, nearly straight hind basitarsis and maculate metasoma, but *not* by its clypeus which is flat in profile like that of male *T. amu*. From *T. hicksi* Sandhouse, it is separated by its tridentate clypeus (quinquedentate in *T. hicksi*), absence of a median tubercle above the antennal sockets, presence of supraorbital foveae, ocelli in a high (not low) equilateral triangle, bluntly rounded humeri (not "bluntly angular"), striate mesonotum and pleura, maculated metasomal terga (not all black), and sternum 7 with its deep, wide, parallel-sided (not trigonal) cleft. The males of all three species have metasomal tergal "acarid chambers."

Of the five known living Holarctic species, judging from Kohl's (1915) account of the two Palearctic species and Pate's (1942) of *T. hicksi* and *T. amu*, *T. quinquenotatus* and *T. hicksi* differ most from the remaining three, but are dissimilar to each other. The Palearctic *T. quinquenotatus* is the most remote from all other species of *Tracheliodes*. *T. amu* and *T. foveolineatus* seem morphologically closely akin to each other and to the Palearctic *T. curvitarsis*, with *T. foveolineatus* being the more strikingly similar to the Palearctic species—as Pate has commented. Discovery of the male sex of *T. foveolineatus* does not resolve the relationship of this species to *T. curvitarsis*, however, as Pate had hoped it would; perhaps discovery of the latter's larva would do so. The sole known Neotropical species, *T. carnavalus* Leclercq (1980), is strikingly different in morphology and livery from all of the above.

The larva.—A single cocooned larva, described below, remained in the trap nest following emergence of the six females and two males. It is to be noted that Evans (1959) judges the larva of *Tracheliodes* to be among the most specialized of the larrine-trypoxyline-crabronine complex.

Larva in diapause: with the characters of the subfamily as successively set forth



Figs. 1–7. Diapausing larva of *Tracheliodes foveolineatus* (Viereck). 1, Head—all outlines and the coronal "suture" from a camera lucida sketch of the fresh specimen; details of setation and foveae entered from the balsam mount. 2, Left antenna—isolated lowermost sensillum drawn above rim of orbit. 3, Spiracle and subatrial trachea. 4, Left mandible—anterior face (the right mandible is similar, but has only 1 basolateral bristle—see Fig. 1). 5, Larva—camera lucida sketch of living larva. 6, Labrum—left half the outer surface, right half the epipharyngeal surface. 7, Maxilla, labium, medial tract of hypopharynx, and apical half of right mandible.

by Evans (1957, 1959, 1964), except that the apical margin of the labrum is not bristly (Fig. 6), and the inner margin of the maxilla has a small lobe (Fig. 7).

Body (in life, Fig. 5): stout, grub-like with head and thorax, and abdominal segments 10–12, flexed ventrally; length (straightened) about 8 mm, widest at abdominal segment 4, 3.1 mm; a transverse, medially divided, brownish, dorsal sclerotization on anterior prothorax; pleural and dorso-lateral lobes prominent, the latter transverse, well-separated medially; apical dorsal lobe of 10th abdominal segment rounded, blunt in profile, overhanging anus; anus directed posteriorly.

Integument of thorax: sparsely and minutely spinulate, spinules of varying sizes and shapes according to location, transforming regionally from acute spines, basally broadened, to smoothly arched plaques; spinulation elsewhere on body still more sparse, occurring nearly exclusively in vicinity of spiracles. Setae few, present along hinder margins of thoracic segments, (20–30 μm long); a single seta below each pleural lobe (Fig. 5).

Spiracles: atrium pale amber, globular in shape; peritreme colorless; atrial microsculpture forming a coarse, open, stretched meshwork; atrial and subatrial openings equal in diameter, the latter encircled by a thickened, darker annulus; subatrium not slender, widening immediately behind subatrial annulus (Fig. 3).

Head (Fig. 1): Width 0.77 mm, height (crown to anterior margin of clypeus) 0.81 mm; coronal "suture" conspicuous; parietal bands evident; epistomal suture weak (more clearly evident in the living larva); antennal orbits (Figs. 1, 2) slightly convex, ovate (54 × 47 μm), with thickened, discrete margin and three sensilla arranged in a low, obtuse triangle with the base ectad, lowest sensillum with a central peg; setae sparse, those on cranium 25–35 μm long; clypeus with a disordered, transverse band of foveae (= setal bases?) and setae at mid-length; a cluster of foveae on genae to each side of clypeus (Fig. 1), as well as on the posterior angles of the postgenae; anterior tentorial arms, hypostomal rod, mandibles and margin of labrum at midpoint, brown.

Mouthparts: Labrum (Figs. 1, 6) 0.3 mm wide, deeply and angularly emarginate, cleft medially (see comment, below), surface with 24 setae, primarily located within distal half; epipharynx (Fig. 6) with a basal and subcentral sensory peg on each side, surface with a complex arrangement of rounded plaques of many sizes and shapes forming an oblique band from labral base to apex and then spread along the apical margin; a medial, spinulose tract, a lateral spinose array. Mandibles (Figs. 1, 4, 7) 0.27 mm long × 0.20 mm wide, apex pointed, inner margin gently sinuate, slightly notched, and bevelled to a cutting edge in anterior half; with one (on right) or two (on left) basolateral bristles. Maxillary palpi (Figs. 1, 7) 30 μm long; galeae 20 μm long, lacinial area spinulose laterally, with fine hairs along inner margin with a distinct, small lobe at level of hypostomal bridge; maxillary palpi (Fig. 7) thicker, with 3 spines in membrane at tip; labial palpi (30 μm long) and galeae (Fig. 7) with at least 2 terminal spines each. Labial palpi similar in girth to galeae, both shorter than spinnerets (40 μm long); hypopharynx (Fig. 7) with a medial array of spines and spinules, broadening apically.

Comment.—The flexion of the body portrayed in Fig. 1 is normal for the living, diapausing larva, and corresponds with Ferton's observations (1890) on the larva of *T. quinquenotatus*. On fixation the larval shape changes markedly, the specimen straightening as in Evans' (1964) figure 10b. Apart from the outlined features of

the head capsule and body, which were drawn by camera lucida before the larva was killed, all other details were obtained from the specimen after death in near-boiling water, decapitation, clearing with KOH, and mounting of the head capsule and the sagittally-divided integument in balsam.

The oblique, open cleft in the labrum (Fig. 1) was very clear prior to mounting the head in balsam. Following slide preparation, the medial tips had become overlapped and presented a quite different appearance—now appearing as though an elongated, very narrow loop (Fig. 6). Whether they could be overlapped this way in life, or indeed whether the cleft resulted from a developmental mishap cannot be ascertained. For the latter reason, the labral cleft (a condition not mentioned for other species) is omitted from the comparisons of the described larvae of *Tracheliodes*.

Another peculiar feature of this larva is the high degree of numerical and positional asymmetries in the distributions of setae and foveae on the head capsule, clypeus, labrum and mandibles, including the foveae in the posterior genal angles at the rear of the head (4 on right, 6 on left, not illustrated). It is not the case, however, for the setae of the maxillae, prementum (6) and mentum (4) (not illustrated); they are equal in number and symmetrically disposed on the two sides in a manner similar to that of *T. amu* (see Evans' fig. 104). Overall, there is no significant excess of bristles or of foveae on one of the two sides.

Comparison of *Tracheliodes* larvae.—With the above caveats in mind, and taking figures and descriptions of the larva of what is probably *T. amu* (Evans, 1964), taken from Krombein's (1967) Arizona trapnests, and of the larva of the Palearctic *T. quinquenotatus* from Grandi (1928, 1934, 1961) as the basis for comparisons, each of the three species appears to be distinct with respect to the complexity and relative distributions of plaques, spinules and spines of the epipharynx (*cf.* Fig. 6 with Evans' fig. 109 and Grandi's [1934] fig. 21-2), as well as with respect to the parietal bands. The latter, evidently lacking in *T. quinquenotatus,* are present in both *T. amu* and *T. foveolineatus,* but in the former they are relatively short and about 2 orbital diameters removed from the antennal orbits, whereas in *T. foveolineatus* the bands are long and removed from the orbits by less than 1 diameter (*cf.* Fig. 1 with Evans' fig. 104).

T. amu and *T. foveolineatus* are similar and differ from *T. quinquenotatus* by their ratios of clypeal width to length (*T. amu* 1.07, *T. foveolineatus* 1.05, *T. quinquenotatus* 1.17), by having 12 pleural lobes per side, not 10, and by not having labial palpi larger than the galeae.

T. amu and *T. quinquenotatus* differ from *T. foveolineatus* by lacking a coronal suture (or ecdysial line), and by having a cluster of 5 sensilla on each side of the epipharynx (foveae in *T. amu,* peg organs in *T. quinquenotatus* ?), whereas such clusters do not occur in the specimen of *T. foveolineatus.*

T. foveolineatus and *T. quinquenotatus* both differ from *T. amu* by an absence of obvious dorsolateral lobes on pro- and mesothorax (and on the metathorax of *T. quinquenotatus* as well), and by having their dorsolateral lobes well separated mediodorsally.

There are additional setational and foveal differences as well, but until many larvae of each species have been studied, the weight to attribute to them is uncertain. However, patterns of epicranial setation seem strikingly different in all three (a transverse row in *T. amu,* 2 convergent rows in *T. foveolineatus,* and

sparse patches in *T. quinquenotatus* (*cf.* Fig. 1 with Evans' fig. 104, and Grandi's [1961] fig. 347-2); likewise each of the former two larvae have 2 convergent lines of 4–5 setae on the interorbital area, whereas *T. quinquenotatus* has 3 interorbital setae per side which form relatively high, obtuse triangles.

T. amu and *T. quinquenotatus* appear to lack interorbital pores, whereas *T. foveolineatus* has 3 per side. *T. foveolineatus* and *T. quinquenotatus* appear to differ from *T. amu* by having their antennal sensilla grouped in a low, obtuse triangular pattern, rather than in a nearly linear array. Finally, because the larva of *T. foveolineatus* has 1 basolateral mandibular seta on its right side, 2 on its left, the value of mandibular setal number in this comparison is doubtful. But were it assumed that the normal number for *T. foveolineatus* is 2, the condition in this species would nevertheless seem to be different from that of *T. quinquenotatus* because the two bristles of the latter (not portrayed by Grandi until 1961) are transverse to the external margin of the mandible, not parallel to it as in *T. foveolineatus*.

Spiracular structure is neither mentioned nor figured for *T. quinquenotatus* by Grandi, but it differs in the two Nearctic species. In *T. amu* the microsculpture of the atrial capsule consists of somewhat elongated polygons, less than twice as long as wide, but in *T. foveolineatus* it takes the form of markedly stretched meshes; only *T. foveolineatus* possesses a stout annulus enclosing the subatrial opening (*cf.* Fig. 3 with Evans' fig. 108).

It is thus clear that the three species are closely allied, but all are easily differentiated, yet none of the attributes shown uniquely by one or another larva is of a remarkable or weighty nature. However, not surprisingly, the two Nearctic species are more similar to each other than either is to *T. quinquenotatus*. Description of the larva of *T. curvitarsis* will therefore be of great interest because, as Pate (1942) points out, and as I comment above, the imago of *T. foveolineatus* is phenotypically far more closely related to it than to *T. quinquenotatus*, and like *T. curvitarsis* (Emery, 1893) it nests in wood borings. What is more, it preys upon an ant, *Liometopum occidentale* Emery first described as a variety of the prey of *T. curvitarsis*, namely as the subspecies *occidentale* of *L. microcephalum* (Emery, 1895). *Tracheliodes quinquenotatus*, on the other hand, preys exclusively on species of *Tapinoma*. Will the larva of *T. curvitarsis* prove to have a labral cleft?

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